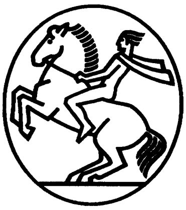

Plant Gene Research

Basic Knowledge and Application

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A Genetic Approach to Plant Biochemistry

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Preface

Biologists ask how the growth, development and behaviour of organisms happen, how these processes are co-ordinated and how they are regulated by the environment. Today the questions are phrased in terms of the genes involved, their structure and the control of their expression. Mutations (recognised by a change in phenotype) label genes and can be used to study gene structure, gene function and the organisation of the genome. This is "Genetics". Study of phenotypes down to the level of the enzymes and structural proteins coded for by genes is "Biochemistry". It is self evident that only by studying phenotype ("Biochemistry") can we do "Genetics" and that "Genetics" (perturbation of the phenotype) is the key to understanding the "Biochemistry". There can surely be no better arguments for a more holistic approach to biology than the massive output of knowledge from microbial "Biochemical Genetics" and the more recent revelations from "Molecular Genetic" studies of development in *Drosophila.*

When one remembers that most of the important conceptual developments in genetics (the discovery of the nucleus, the hereditary mechanism, cytoplasmic inheritance, mutation, the one gene-one enzyme hypothesis, semiconservative replication of DNA, heterochromatin, transposable elements) were discovered by biologists working with plants, it is surprising that the genetic approach to the study of basic plant properties is so underdeveloped when compared to all other biological systems. Because the advantages, the directness and reduced ambiguity, of studying normal functions by perturbing or eliminating single genes are so obvious when compared to the circumstantial approach of pure physiology and biochemistry, there must exist strong reasons why the biochemical genetics of plants is still an emerging field. Undoubtedly there are aspects of biochemistry or molecular biology common to several organisms that one would not choose to study with a complex higher plant. There are not that many efficient cytogenetic systems in plants, like those of maize, *Arabidopsis* or tomato, which are at the same time suited for particular biochemistry. There are also various physical criteria for the isolation of mutants that must be met: Where traits must be screened for by examination of individual plants, the investment of the necessary time and space may be inhibiting. The selection techniques applicable to whole plants required for the rescue of specific mutants may not be available. Lethal nutritional mutants isolated with ease from *Neurospora* may be impossible to find given the complex life cycle of the higher plant.

The "Princes of Serendip" were probably not very far away when studies of genetic aspects of gibberellins (Chapter 1), abscisic acid (Chapter 2), photosynthesis (Chapter 3) and endosperm proteins (Chapter 7) got under way. Some areas of investigation were set off initially by spontaneous variation in a field and a passing, curious biologist. Others started with the analysis of randomly generated variation following mutagenesis or a dip into a local seed collection to look for a useful variant. The rapid success of the alcohol dehydrogenase systems (Chapter 4) and the growth of nitrate reductase studies (Chapter 5) are clearly due to powerful and simple chemical selection systems being available for mutants deficient in the enzymes, and to the conditional lethality of the traits. There are, unfortunately, very few positive selection systems for deficient mutants. Cell and protoplast culture offer both a method for conveniently selecting or screening for mutants amongst very large cell populations and a way of rescuing lethal nutritional mutants. Isolation of variation is carried out at the cell level and thus many mutants may be found that would not otherwise be recognised by plant selection. After selection, plants may be regenerated and normal genetics and biochemistry undertaken. Cell culture was central to the isolation of the majority of nitrate reductase deficient mutants (Chapter 5). An account of the recent successes in the isolation of plant auxotrophs via cell and protoplast culture is given in Chapter 10.

The life cycle of the majority of higher plants includes the liberation of enormous numbers of semi-autonomous haploid gametophytes (pollen grains). The realisation that many important sporophytic genes are expressed in pollen grains and that the selection for new alleles may occur in natural populations at this level has stimulated interest in gametophytic gene expression (Chapter 9) and the possibility that mutant selection using pollen could increase the variation available to the breeder and the biochemist. Plant breeding rather than biochemistry is probably the greater stimulus to research in nodulation and nitrogen fixation in legumes (Chapter 6) and in plant/pathogen genes (Chapter 8) but, as the authors point out, in these and so many other areas of plant breeding there is an increasing need to understand the mechanisms and the molecular events involved. The protection and stabilisation of our plant resources is a worthy target for plant biochemical genetics.

Basel, August 1986 A. D. Blonstein and P. J. King

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